Diffusion in agar: distance and time

Student activity • practical and reasoning

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The question

How far does the colour-change boundary move in a fixed time?

Use matched cubes and separate exposure times to measure a visible boundary, then evaluate the limits of this diffusion model.

Equipment

- Eye protection, three 100 cm^3 beakers, forceps, ruler, timer and tile
- Three teacher-cut 1 cm indicator-agar cubes
- 90 cm^3 supplied 0.1 mol dm^{-3} hydrochloric acid; rinse water

Wear eye protection and avoid splashes. Do not eat the agar. Students use pre-cut cubes; the teacher handles the blade for centre sections on a stable tile. Report spills or cuts immediately.

Course coverage: Shared Biology / Double Award: 2.16–2.17. Factors and a non-living diffusion model.

Plan, model or apparatus sketch

Draw and label the apparatus or biological model; identify one limitation.

Method and reasoning

Read the whole sequence before starting

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1. Wear eye protection. Label three beakers for 2, 4 and 6 minutes. Put 30 cm^3 of supplied 0.1 mol dm^{-3} hydrochloric acid in each; keep temperature and volume the same.

2. Measure three teacher-cut 1 cm indicator-agar cubes. Immerse one cube fully in each beaker and start timing; use forceps, not fingers.

3. At each allocated time remove its cube and rinse briefly as directed to stop further exposure. The teacher cuts it through the centre on a tile; keep fingers away from the blade.

4. Measure the remaining coloured core width along a central line. Calculate penetration depth as (original width – core width)/2. If fully decolourised, record that the boundary reached the centre; do not invent a larger distance.

5. Pool matched class results and plot penetration depth against exposure time, with repeat spread. Keep cube dimensions, agar batch, acid concentration, volume and temperature constant.

6. Explain how shorter diffusion distance, larger exchange area, a steeper concentration gradient and higher temperature can affect exchange. State why this reacting indicator model is not a living membrane.

Cleanup

- Return acid and indicator residues to the labelled waste containers as directed.
- Place agar in solid waste, not the sink; rinse apparatus, clean the bench and wash hands.

Record your evidence

Blank spaces are for your own work

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Reference and task data

Agar is a non-living gel. The colour boundary reflects acid entering the gel and reacting with alkali/indicator; it is not a direct image of individual particles or a pure diffusion coefficient. Depth calculation example only: a 10 mm cube with a 6 mm coloured core gives (10−6)/2 = 2 mm from each face.

Example / trial	Observation / evidence	Explanation / limit
2 min: width / core / depth		
4 min: width / core / depth		
6 min: width / core / depth		

Show your calculations, labelled model or correction here.

Explain and evaluate

Use evidence and show calculation steps where relevant

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1. What is varied in this experiment?

2. Calculate depth for a 10 mm cube with a 4 mm coloured core.

3. Name three controls.

4. Why cut through the centre?

5. Why can fully colourless cubes give only a bound on penetration?

6. Give two limits when applying this model to cells.